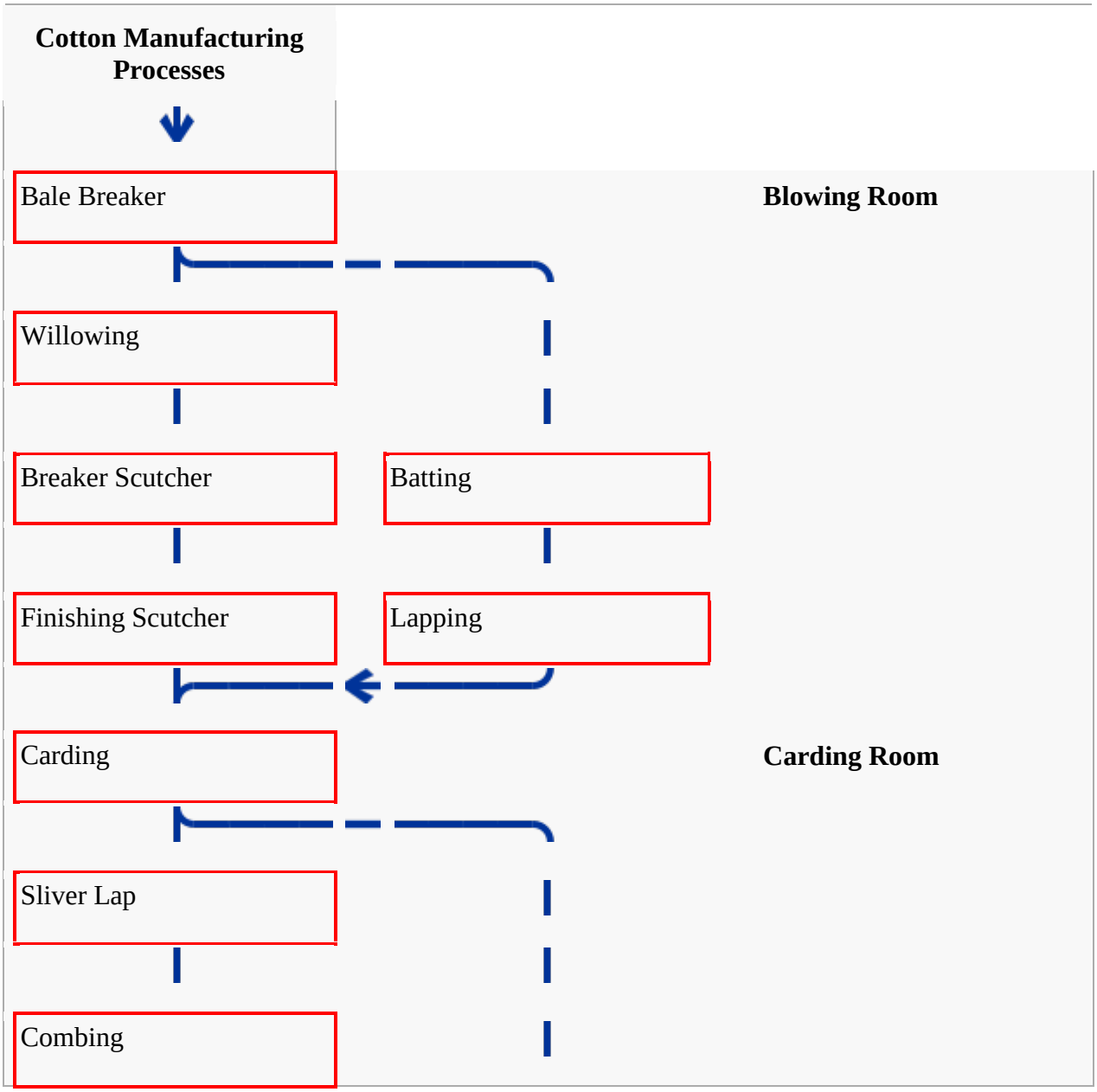
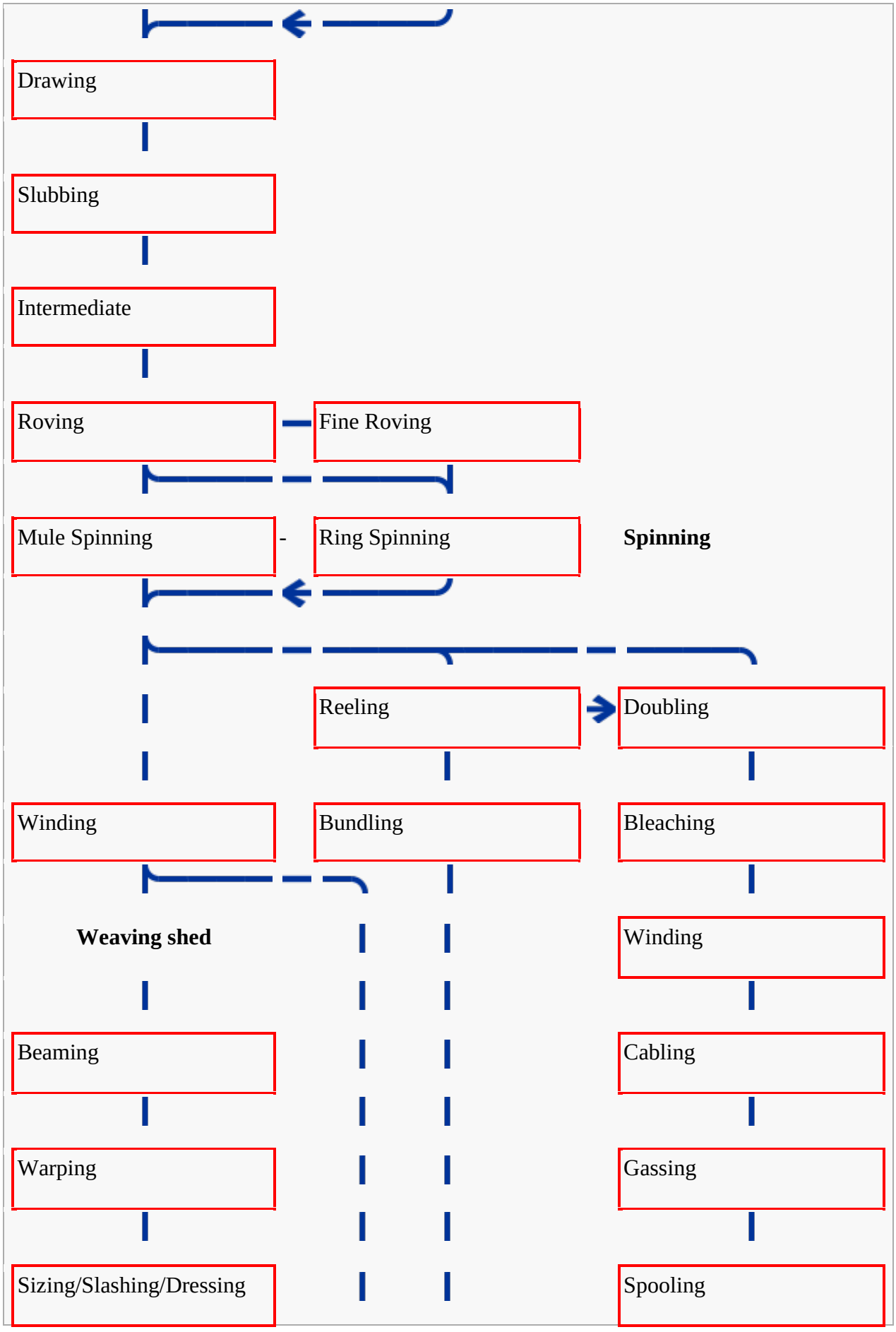
Appendix - I

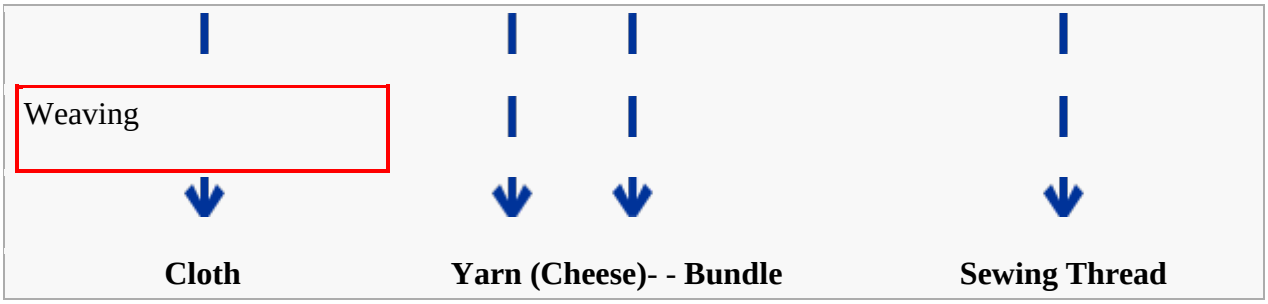
COTTON TO CLOTH

Cotton is a major industry. It is based on the conversion of fiber into yarn, yarn into fabric. These are then dyed or printed, fabricated into clothes. Different types of fiber are used to produce yarn. Cotton remains the most important natural fiber. There are many variable processes available at the spinning and fabric-forming stages coupled with the complexities of the finishing and colorations processes to the production of a wide ranges of products. There remains a large industry that uses hand techniques to achieve the same results.

Processing of cotton




Drawing
Slubbing
Intermediate
Roving
Fine Roving
Mule Spinning
-
Ring Spinning
Spinning
Reeling
Doubling
Winding
Bundling
Bleaching
Weaving shed
Winding
Beaming
Cabling
Warping
Gassing
Sizing/Slashing/Dressing
Spooling



(Source: wikipedia.com)

Cotton is the world's most important natural fibre. In the year 2007, the global yield was 25 million tons from 35 million hectares cultivated in more than 50 countries.

There are six stages

1. Cultivating and Harvesting
2. Preparatory Processes
3. Spinning
4. Weaving or Knitting
5. Finishing
6. Marketing

1. Cultivating and harvesting

Cotton is grown anywhere with long, hot dry summers with plenty of sunshine and low humidity. Indian cotton, gossypium arboreum, is finer but the staple is only suitable for hand processing. American cotton, gossypium hirsutum, produces the longer staple needed for machine production.[3] Planting is from September to mid November and the crop is harvested between March and June. The cotton bolls are harvested by stripper harvesters and spindle pickers that remove the entire boll from the plant. The cotton boll is the seed pod of the cotton plant, attached to each of the thousands of seeds are fibres about 2.5 cm long.

- **Ginning**

The seed cotton goes in to a Cotton gin. The cotton gin separates seeds and removes the "trash" (dirt, stems and leaves) from the fibre. In a saw gin, circular saws grab the fibre and pull it through a grating that is too narrow for the seeds to pass. A roller gin is used with longer staple cotton. Here a leather roller captures the cotton. A knife blade, set close to the roller, detaches the seeds by drawing them through teeth in circular saws and revolving brushes which clean them away.

The ginned cotton fibre, known as lint, is then compressed into bales which are about 1.5 m tall and weigh almost 220 kg. Only 33% of the crop is usable lint. Commercial cotton is priced by quality, and that broadly relates to the average length of the staple, and the variety of the plant. Longer staple cotton (2½ in to 1¼ in) is called Egyptian, medium staple (1¼ in to ¾ in) is called American upland and short staple (less than ¾ in) is called Indian.

The cotton seed is pressed into a cooking oil. The husks and meal are processed into animal feed, and the stems into paper.

2. Preparatory processes - preparation of yarn

- Ginning, bale-making and transportation is done in the country of origin.
- Opening and cleaning

Platt Bros. Picker

Cotton mills get the cotton shipped to them in large, 500 pound bales. When the cotton comes out of a bale, it is all packed together and still contains vegetable matter. The bale is broken open using a machine with large spikes. It is called an **Opener**. In order to fluff up the cotton and remove the vegetable matter, the cotton is sent through a picker, or similar machines. The cotton is fed into a machine known as a **picker**, and gets beaten with a beater bar in order to loosen it up. It is fed through various rollers, which serve to remove the vegetable matter. The cotton, aided by fans, then collects on a screen and gets fed through more rollers till it emerges as a continuous soft fleecy sheet, known as a lap.

Blending, **Mixing & Scotching**

Scotching refers to the process of cleaning cotton of its seeds and other impurities. The first scotching machine was invented in 1797, but did not come into further mainstream use until after 1808 or 1809, when it was introduced and used in Manchester, England. By 1816, it had become generally adopted. The scotching machine worked by passing the cotton through a pair of rollers, and then striking it with iron or steel bars called beater bars or beaters. The beaters, which turn very quickly, strike the cotton hard and knock the seeds out. This process is done over a series of parallel bars so as to allow the seeds to fall through. At the same time, air is blown across the bars, which carries the cotton into a cotton chamber.

Carding

Carding machine

A Combing machine

Carding: the fibers are separated and then assembled into a loose strand (sliver or tow) at the conclusion of this stage.

The cotton comes off of the picking machine in laps, and is then taken to carding machines. The carders line up the fibres nicely to make them easier to spin. The carding machine consists mainly of one big roller with smaller ones surrounding it. All of the rollers are covered in small teeth, and as the cotton progresses further on the teeth get finer (i.e. closer together). The cotton leaves the carding machine in the form of a sliver; a large rope of fibers.

Note: In a wider sense Carding can refer to these four processes: Willowing- loosening the fibres; Lapping- removing the dust to create a flat sheet or lap of cotton; Carding- combing the tangled lap into a thick rope of 1/2 in in diameter, a sliver; and Drawing- where a drawing frame combines 4 slivers into one- repeated for increased quality.

- **Combing** is optional, but is used to remove the shorter fibers, creating a stronger yarn.
- **Drawing** the fibers are straightened

Several slivers are combined. Each sliver will have thin and thick spots, and by combining several slivers together a more consistent size can be reached. Since combining several slivers produces a very thick rope of cotton fibers, directly after being combined the slivers are separated into roving. These roving (or stubbing) are then what are used in the spinning process.

Generally speaking, for machine processing, a roving is about the width of a pencil.

- Drawing frame: Draws the strand out
- Stubbing Frame: adds twist, and winds onto bobbins

- Intermediate Frames: are used to repeat the stubbing process to produce a finer yarn.
- Roving frames: reduces to a finer thread, gives more twist, makes more regular and even in thickness, and winds onto a smaller tube.

3. Spinning - yarn manufacture

Spinning

Most spinning today is done using Break or Open-end spinning, this is a technique where the staples are blown by air into a rotating drum, where they attach themselves to the tail of formed yarn that is continually being drawn out of the chamber. Other methods of break spinning use needles and electrostatic forces. This method has replaced the older methods of ring and mule spinning. It is also is easily adapted for artificial fibers. The spinning machines takes the roving, thins it and twists it, creating yarn which it winds onto a bobbin.

In mule spinning the roving is pulled off a bobbin and fed through some rollers, which are feeding at several different speeds. This thins the roving at a consistent rate. If the roving was not a consistent size, then this step could cause a break in the yarn, or could jam the machine. The yarn is twisted through the spinning of the bobbin as the carriage moves out, and is rolled onto a cylinder called a spindle, which then produces a cone-shaped bundle of fibers known as a "cop", as the carriage returns. Mule spinning produces a finer thread than the less skilled ring spinning.

- The mule was an intermittent process, as the frame advanced and returned a distance of 5ft.It was the descendant of 1779 Crompton device. It produces a softer less twisted thread that was favoured for fines and for weft.
- The ring was a descendant of the Arkwright water Frame 1769. It was a continuous process, the yarn was coarser, had a greater twist and was stronger so was suited to be warp. Ring spinning is slow due to the distance the thread must pass around the ring, other methods have been introduced.

Sewing thread, was made of several threads twisted together, or doubled.

Checking

This is the process where each of the bobbins is rewound to give a tighter bobbin.

Folding and twisting

Plying is done by pulling yarn from two or more bobbins and twisting it together, in the opposite direction that in which it was spun. Depending on the weight desired, the cotton may or may not be plied, and the number of strands twisted together varies.

Gassing

Gassing is the process of passing yarn, as distinct from fabric very rapidly through a series of Bunsen gas flames in a gassing frame, in order to burn off the projecting fibers and make the thread round and smooth and also brighter. Only the better qualities of yarn are gassed, such as that used for voiles, poplins, venetians, gabardines, many Egyptian qualities, etc. There is a loss of weight in gassing, which varies' about 5 to 8 per cent., so that if a 2/60's yarn is required 2/56's would be used. The gassed yarn is darker in shade afterwards, but should not be scorched.

Measurements

Cotton Counts: The number of pieces of thread, 840 yards long needed to make up 1 lb weight. 10 count cotton means that 10x840 yd weighs 1 lb. This is coarser than 40 count cotton where 40x840 yards are needed. In the United Kingdom, Counts to 40s are coarse (Oldham Counts), 40 to 80s are medium counts and above 80 is a fine count. In the United States ones to 20s are coarse counts.

- Hank: A length of 7 leas or 840 yards
- Thread: A length of 54 in (the circumference of a warp beam)
- Bundle: Usually 10 lb
- Lea: A length of 80 threads or 120 yards
- Denier: this is an alternative method. It is defined as a number that is equivalent to the weight in grams of 9000m of a single yarn. 15 denier is finer than 30 denier.
- Tex: is the weight in grams of 1 km of yarn.

The worsted hank is only 560 yd

4. Weaving-fabric manufacture

The weaving process uses a loom. The length way threads are known as the warp, and the cross way threads are known as the weft. The warp which must be strong needs to be presented to loom on a warp beam. The weft passes across the loom in a shuttle, that carries the yarn on a pin. These pins are automatically changed by the loom. Thus, the yarn needs to be wrapped onto a beam, and onto pins before weaving can commence.

- **Winding**

After being spun and plied, the cotton thread is taken to a warping room where the winding machine takes the required length of yarn and winds it onto warper's bobbins

Warping or beaming

A Warper

Racks of bobbins are set up to hold the thread while it is rolled onto the warp bar of a loom. Because the thread is fine, often three of these would be combined to get the desired thread count.

Sizing

Slasher sizing machine needed for strengthening the warp by adding starch to reduce breakage of the yarns.

Drawing in, Looming

The process of drawing each end of the warp separately through the dents of the reed and the eyes of the healds, in the order indicated by the draft.

Pirning (Processing the weft)

Pirn winding frame was used to transfer the weft from cheeses of yarn onto the pirns that would fit into the shuttle

Weaving

At this point, the thread is woven. Depending on the era, one person could manage anywhere from 3 to 100 machines. In the mid nineteenth century, four was the standard number. A skilled weaver in 1925 would run 6 Lancashire Looms. As time progressed new mechanisms were

added that stopped the loom any time something went wrong. The mechanisms checked for such things as a broken warp thread, broken weft thread, the shuttle going straight across, and if the shuttle was empty. Forty of these Northrop Looms or automatic looms could be operated by one skilled worker.

A Draper loom in textile museum, Lowell, Massachusetts. The three primary movements of a loom are shedding, picking, and beating-up.

- *Shedding*: The operation of dividing the warp into two lines, so that the shuttle can pass between these lines. There are two general kinds of sheds-"open" and "closed." Open Shed-The warp threads are moved when the pattern requires it-from one line to the other. Closed Shed-The warp threads are all placed level in one line after each pick.

- *Picking*: The operation of projecting the shuttle from side to side of the loom through the division in the warp threads. This is done by the over pick or under pick motions. The over pick is suitable for quick-running looms, whereas the under pick is best for heavy or slow looms.

- *Beating-up*: The third primary movement of the loom when making cloth, and is the action of the reed as it drives each pick of weft to the fell of the cloth.

The Lancashire Loom was the first semi-automatic loom. Jacquard looms and Dobby looms are looms that have sophisticated methods of shedding. They may be separate looms, or mechanisms added to a plain loom. A Northrop Loom was fully automatic and was mass produced between 1909 and the mid-1960s. Modern looms run faster and do not use a shuttle: there are air jet looms, water jet looms and rapier looms.

Measurements

Ends and Picks: Picks refer to the weft, ends refer to the warp. The coarseness of the cloth can be expressed as the number of picks and ends per quarter inch square, or per inch square. Ends is always written first. For example: Heavy domestics are made from coarse yarns, such as 10's to 14's warp and weft, and about 48 ends and 52 picks.

Associated job titles

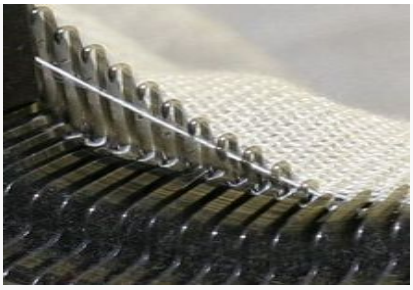
- Piecer
- Scavenger
- Weaver
- Tackler
- Draw boy
- Pirner

Issues

When a hand loom was located in the home, children helped with the weaving process from an early age. Piecing needs dexterity, and a child can be as productive as an adult. When weaving moves from the home to the mill, children are often allowed to *help* their older sisters, and laws have to be made to prevent child labourbecoming established.

Knitting- fabric manufacture

A circular knitting machine.



Close-up on the needles.

Knitting by machine is done in two different ways; warp and weft. Weft knitting (as seen in the pictures) is similar in method to hand knitting with stitches all connected to each other horizontally. Various weft machines can be configured to produce textiles from a single spool of yarn or multiple spools depending on the size of the machine cylinder (where the needles are bedded). In a warp knit there are many pieces of yarn and there are vertical chains, zigzagged together by crossing the yarn. Cotton

Warp knits do not stretch as much as a weft knit, and it is run-resistant. A weft knit is not run-resistant, but stretches more. This is especially true if spools of spandex are processed from separate spool containers and interwoven through the cylinder with cotton yarn, giving the finished product more flexibility and making it less prone to having a 'baggy' appearance. The average t-shirt is a weft knit.

5. Finishing- processing of textiles

The woven cotton fabric in its loom-state not only contains impurities, including warp size, but requires further treatment in order to develop its full textile potential. Furthermore, it may receive considerable added value by applying one or more finishing processes.

Desizing

Depending on the size that has been used, the cloth may be steeped in a dilute acid and then rinsed, or enzymes may be used to break down the size.

Scouring

Scouring, is a chemical washing process carried out on cotton fabric to remove natural wax and non-fibrous impurities (e.g. the remains of seed fragments) from the fibres and any added soiling or dirt. Scouring is usually carried in iron vessels called kiers. The fabric is boiled in an alkali, which forms a soap with free fatty acids (saponification). A kier is usually enclosed, so the

solution of sodium hydroxide can be boiled under pressure, excluding oxygen which would degrade the cellulose in the fibre. If the appropriate reagents are used, scouring will also remove size from the fabric although desizing often precedes scouring and is considered to be a separate process known as fabric preparation. Preparation and scouring are prerequisites to most of the other finishing processes. At this stage even the most naturally white cotton fibres are yellowish, and bleaching, the next process, is required.

Bleaching

Bleaching improves whiteness by removing natural coloration and remaining trace impurities from the cotton; the degree of bleaching necessary is determined by the required whiteness and absorbency. Cotton being a vegetable fibre will be bleached using an oxidizing agent, such as dilute sodium hypochlorite or dilute hydrogen peroxide. If the fabric is to be dyed a deep shade, then lower levels of bleaching are acceptable, for example. However, for white bed sheetings and medical applications, the highest levels of whiteness and absorbency are essential.

Mercerising

A further possibility is mercerizing during which the fabric is treated with caustic soda solution to cause swelling of the fibres. This results in improved lustre, strength and dye affinity. Cotton is mercerized under tension, and all alkali must be washed out before the tension is released or shrinkage will take place. Mercerizing can take place directly on grey cloth, or after bleaching.

Many other chemical treatments may be applied to cotton fabrics to produce low flammability, crease resist and other special effects but four important non-chemical finishing treatments are:

Singeing

Singeing is designed to burn off the surface fibres from the fabric to produce smoothness. The fabric passes over brushes to raise the fibres, then passes over a plate heated by gas flames.

Raising

Another finishing process is raising. During raising, the fabric surface is treated with sharp teeth to lift the surface fibres, thereby imparting hairiness, softness and warmth, as in flannelette.

Calendaring

Calendaring is the third important mechanical process, in which the fabric is passed between heated rollers to generate smooth, polished or embossed effects depending on roller surface properties and relative speeds.

Shrinking (Sanforizing)

Finally, mechanical shrinking (sometimes referred to as sanforizing), whereby the fabric is forced to shrink width and/or lengthwise, creates a fabric in which any residual tendency to shrink after subsequent laundering is minimal.

Dyeing

Finally, cotton is an absorbent fibre which responds readily to colouration processes. Dyeing, for instance, is commonly carried out with an anionic direct dye by completely immersing the fabric (or yarn) in an aqueous dyebath according to a prescribed procedure. For improved fastness to washing, rubbing and light, other dyes such as vats and reactives are commonly used. These require more complex chemistry during processing and are thus more expensive to apply.

Printing

Printing, on the other hand, is the application of colour in the form of a paste or ink to the surface of a fabric, in a predetermined pattern. It may be considered as localised dyeing. Printing designs onto already dyed fabric is also possible.